Projections of Health Care Expenditures as a Share of the GDP: Actuarial and Macroeconomic Approaches

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Study Question. Can the steady increases in health care expenditures as a share of GDP projected by widely cited actuarial models be rationalized by a macroeconomic model with sensible parameters and specification?

Data Sources. National Income and Product Accounts, and Social Security and Health Care Financing Administration are the data sources used in parameter estimates.

Study Design. Health care expenditures as a share of gross domestic product (GDP) are projected using two methodological approaches–actuarial and macroeconomic–and under various assumptions. The general equilibrium macroeconomic approach has the advantage of allowing an investigation of the causes of growth in the health care sector and its consequences for the overall economy.

Data Collection Methods. Simulations are used.

Principal Findings. Both models unanimously project a continued increase in the ratio of health care expenditures to GDP. Under the most conservative assumptions, that is, robust economic growth, improved demographic trends, or a significant moderation in the rate of health care price inflation, the health care sector will consume more than a quarter of national output by 2065. Under other (perhaps more realistic) assumptions, including a continuation of current trends, both approaches predict that health care expenditures will comprise between a third and a half of national output. In the macroeconomic model, the increasing use of capital goods in the health care sector explains the observed rise in relative prices. Moreover, this "capital deepening" implies that a relatively modest fraction of the labor force is employed in health care and that the rest of the economy is increasingly starved for capital, resulting in a declining standard of living.

Keywords. Health care expenditures, economic projections, macroeconomic models, medical price inflation

A growing share of the gross domestic product (GDP) of the United States is expended on health care. The share was less than 7½ percent in 1970; by 1991, it had increased to nearly 13 percent. An expanding portion for an expenditure category in a market economy is not necessarily a cause for concern–tastes, technologies, and social conditions change, and incomes increase. The health care sector, however, is not subject in many respects to the discipline of market pressures to contain costs and to encourage tradeoffs, based on consumer tastes, between categories of expenditures. Hence, unlike other sectors of the economy, the growing share of output represented by health care expenditures may indeed be a signal of systemic problems worthy of attention (see also Fuchs 1990).

Concomitant with its increasing percentage of output, other telltale signs of trouble abound for the health care sector, with adverse implications for the general economy. First, according to its 1992 Annual Report, the Medicare program will go bankrupt within the next ten years unless benefits are cut or taxes are raised significantly. Second, Medicaid consumes an ever-growing proportion of state government budgets, necessitating tax increases and cuts in other programs. Third, expenditures of employers on health insurance for active and retired workers have skyrocketed, impinging significantly on profits and wages. According to Warshawsky (1992), a new accounting standard to be implemented by 1993 will cause the reported expense for retiree health benefits to increase, on average, about fivefold, reducing corporate profits by 20 percent. Much of the "punch" imparted by the adoption of accrual accounting is due to the projection of continued rapid price inflation for health care. Finally, there are increasing doubts about whether or not the current incentive structure for health care providers leads to the efficient utilization of resources (e.g., Monheit 1990; Feinglas, Martin, and Sen 1991).

The main purposes of this article are (1) to investigate more formally whether current trends in the health care sector are sustainable and their impact on long-run economic performance, and (2) to compare actuarial and macroeconomic methodological approaches to forecasting health care expenditures as a proportion of GDP. Numerous sensitivity checks

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are performed for both methodologies. The forecast horizon runs through the year 2065–the same horizon used in assessing officially the long-term financial health of the Social Security and Medicare programs–although we will also pay attention to the near-term prognosis.

The actuarial approach we present here uses the general methodology and many of the assumptions employed by the actuaries at the Social Security Administration (SSA) and the Health Care Financing Administration (HCFA). In fact, HCFA actuaries conducted a similar exercise (Division of National Cost Estimates 1987). In this article, however, more recent data and additional methods are used for a longer projection horizon.

The actuarial approach is straightforward and used widely by government policymakers and other analysts. Yet it is not necessarily internally consistent, and it may miss some potentially significant interactions in sectors of the economy. In particular, as the health care sector grows, it is possible that the nature of the economy itself will change, through changes in relative prices, through the substitution of labor and capital, or through differential rates of productivity growth.[1] These changes could alleviate or exacerbate current problems. Furthermore, a macroeconomic approach gives greater scope to an investigation of the consequences of imposed changes or shocks.

The simple general-equilibrium macroeconomic model presented here has two sectors of production (health care and everything else) and two factors of production (labor and capital). Despite its apparent simplicity, this macro model has several advantages over an elaborate econometric model prepared by Anderson et al. (1990) to project health care expenditures through the year 2050. The Anderson model focused on macroeconomic and demographic factors in the demand for health care; apparently, no effort was made to examine and model the supply of health care services, as done here. Moreover, the Anderson model, estimated on 1980 survey data, forecasts health expenditures as a share of gross national product (GNP) to be no more than 13 percent at any time through 2050. The model presented here will reflect more recent data and trends.

ACTUARIAL ANALYSIS

The actuarial analysis uses the general methodology and many of the assumptions employed by HCFA and SSA actuaries. In particular, the most recent demographic projections of the SSA actuaries are applied to the estimates of health care expenditures by age group as made by HCFA actuaries and others. The resulting demographic-sensitive projections of health expenditures are expanded further by forecasts of utilization rates and of the rate of inflation in health care prices. Two different forecasts

for the inflation rates are assessed in this article: a regression forecast and a forecast based on projections used by HCFA actuaries in analyses of the financial soundness of the Medicare system. Finally, the resulting projections of health care expenditures are divided by the GDP projections of the SSA actuaries to arrive at a conclusion about the sustainability of current trends.

AGE PROFILE OF HEALTH CARE EXPENDITURES

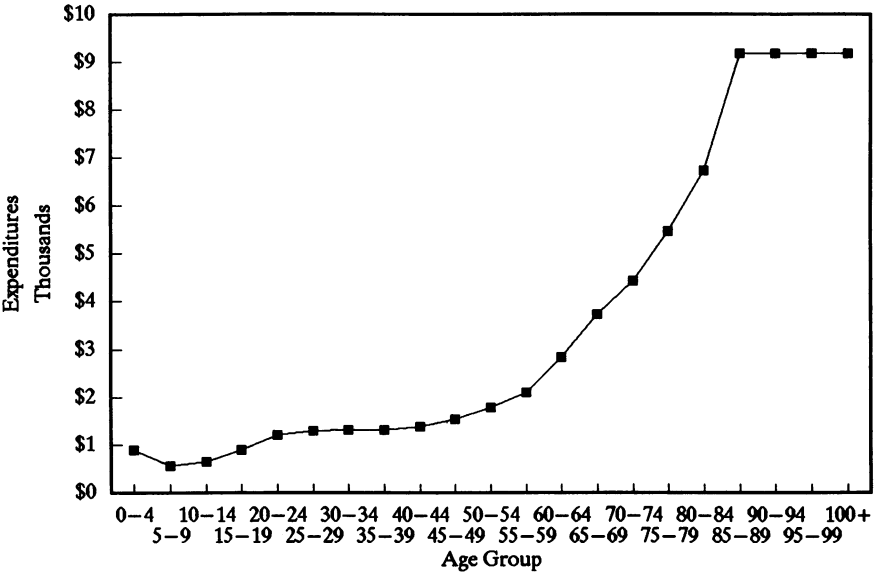
The main source of recent information about personal health expenditures by age group in the United States is Waldo, Sonnefeld, McKusick, and Arnett (1989). These actuaries disaggregated spending in 1987 for various types of health goods and services for each source of payment (Medicare, Medicaid, and so on) and then divided those payments among age groups. They separated the population into three age groups: people under 19 years of age ("young"), those ages 19 through 64 ("middle"), and those 65 years of age or over ("old"). The old group was further subdivided into quinquennial age groups through age 84 and a group for those 85 years or over.

Considerable variation by age is hidden in the per capita expenditures calculated for the middle and, to a lesser extent, the young groups in the statistics reported by Waldo et al. Two other studies were therefore consulted to fill in the gaps in information about the expenditure-age profile. Brown (1989) reported health care expenditures in Canada by 19 quinquennial age groups, beginning at birth through those age 90 or over. He relied on a composite of various studies done for national and provincial governments concerning different categories of health care for the years 1978–1979, 1980–1981, and 1983–1984. Hutchings and Ullman (1983) examined the claim cost experience by quinquennial ages in the middle age group in 1978 on small group health policies issued in New York state by Blue Cross and Blue Shield. The profiles (although not the levels) in the two studies were similar. In this article, the quinquennial age profiles of health care expenditures for males and females for ages through 65 reported in Brown are adjusted to reflect the levels of per capita U.S. expenditures in 1987 shown in Waldo et al. for the broad young and middle age groups. The resulting information for the quinquennial age groups below age 65 supplements the expenditure estimates for the age groups above age 65 already developed by Waldo et al. The complete profile is shown in Figure 1.

DEMOGRAPHIC PROJECTIONS

Next, a demographic-sensitive projection of national health expenditures is developed by applying the 1987 per capita expenditure-age profile to the demographic projections of the SSA actuaries for every five years from 1990 through 2065.[2] The "intermediate" demographic projection featured here is

Figure 1: Age Profile of Personal Health Expenditures (Per Capita in 1987 Dollars)



Sources: Waldo, Sonnefeld, McKusick, and Arnett (1989) and Brown (1989).

the best estimate of the SSA actuaries of the future course of the population. Two other demographic projections–"optimistic" and "pessimistic"–used in the *1992 Annual Report* of the Social Security Trustees give high and low uncertainty bounds around the intermediate projection.

Under the intermediate projection, the U.S. population grows over the 75-year period from 260 million to over 352 million persons. The population, however, also ages considerably; the proportion age 65 or over increases from 12 to 22½ percent over the period. The aging of the baby boom generation is concentrated in the years 2010 through 2030. The projection of health care expenditures that results from the intermediate demographic scenario indicates a doubling in expenditures. About one-third of the increase is due to overall growth in the population and the rest is accounted for by the aging of the population.

Under the optimistic demographic projection, birth, immigration, and death rates are higher than forecast for the intermediate projection. The population grows to almost 437 million, and the proportion age 65 or over increases to only 17 percent by 2065. Under this projection, the increase in health care expenditures (again about a doubling) owes about two-thirds to growth in population and about a third to its aging. The pessimistic

projection forecasts lower birth, immigration, and death rates than in the intermediate projection. The population grows to only 292 million, but the proportion age 65 or over increases to over 30 percent by 2065! Under this demographic projection, health care expenditures increase by 80 percent, almost entirely due to the aging of the population.

TWO FORECASTS OF HEALTH CARE PRICE INFLATION

Surpassing demographics in importance as a factor in the overall projection exercise is the long-run trajectory of the relative price of health care services, that is, the difference between the rates of health care and general price inflation. Comparing the change in the last three decades in the fixed-weight price index for personal health care expenditures, constructed by HCFA, to the change in the GDP price deflator, health care shows almost uniformly a rate of price inflation significantly higher than in all sectors of the economy taken together. Hence, any reasonable forecast of health care price inflation should be higher than the forecast of the rate of general inflation used in the projection of GDP.

One forecast of the health care inflation rates is derived from simple regression analysis. The regression, estimated over the period 1961–1989, uses the rate of health care price inflation as a dependent variable, and a constant, general price inflation and "household exposure to health care costs" as independent variables. The household exposure to health costs is measured as out-of-pocket health payments as a percentage of total health expenditures. Such exposure to costs declined steadily over the period, with a particularly notable drop following the introduction of Medicare in 1966. The decline may also be attributable to improved coverage provided by many employer-sponsored group health insurance plans. The rationale for including an exposure variable is that health care is to some extent a discretionary decision. A fully insured individual will exercise fully his or her discretion to obtain the best care available frequently and without regard to cost; as the number of such individuals increases, demand pressures on the system boost prices. This logic is consistent with the findings of Feldstein (1972).

As shown in Table 1, regression analysis indicates that the rate of health care inflation is 87 percent of the rate of general inflation, plus a constant 4.2 percentage points, less .06 multiplied by the percentage exposure. Assuming that all general inflation eventually flows to health care price inflation as well, and that household exposure to health costs is expected to continue at its 1990 level of 20 percent, a reasonable and simple forecast of the long-run rate of health care price inflation is 2.5 percentage points added to

the rate of general price inflation.[3] This inflation forecast will be called the "regression" forecast.

The second forecast of the long-run rate of health inflation is based on assumpTions made by HCFA actuaries for the *Report on Medicare Projections* by the Health Technical Panel to the 1991 Advisory Council on Social Security (J. Lave, Chairperson) March 1991. The HCFA forecast considered the main components of health care costs–earnings of health care providers and nonlabor inputs of hospitals–and their relationship to the general economy. More specifically, the HCFA actuaries projected that the earnings of hospital workers will grow with average earnings in the economy, plus 0.5 percent over the next 25 years (reflecting a continuation of the recent trend), and will level off at the rate of increase in economywide earnings thereafter. The earnings of physicians and other health care providers will continue to grow in line with recent historical trends over the next 25 years, and then will taper off to grow at the rate of increase in GDP. Finally, it is assumed that nonlabor inputs of hospitals will rise with the consumer price index (CPI), plus 0.5 percent over the next 25 years, and will rise with the CPI thereafter.

This section implements the HCFA or "structural" forecast more simply. The rate of health care price inflation is assumed to equal the rate of increase in the earnings of hospital workers and physicians, as projected by the HCFA actuaries and consistent with the forecast of GDP.

A final factor in the projection of national health expenditures takes into account an increase in the utilization of health care services, after adjustment for demographic changes. The HCFA actuaries project that growth in age-adjusted hospital admissions will be similar to the growth experienced in years prior to the implementation in 1983 of the prospective payment system for the Hospital Insurance portion of the Medicare program. They project that this growth rate in utilization, 1.3 percent, will gradually taper off

Table 1: Ordinary Least Squares Regression, Health Care Price Inflation, 1961–1989

Dependent Variable		
Annual Rate of Change in Personal Health Care Expenditures Fixed-Weight Price Index		
Independent Variables	*Coefficient*	t-*Statistic*
Constant	4.231	3.861
GNP deflator	.867	9.876
Exposure of households (percentage points)	−.057	−2.181
R^2	.882	
D-W statistic	1.303	
Standard error	.900	

to zero during the next 25 years. For both regression and structural inflation forecasts in this section, as well as for the macroeconomic simulation model later in the article, a more conservative projection of utilization is made: growth in utilization of health care services will be 1 percent for the next 10 years, 0.5 percent for 15 years after that, and then zero for the remainder of the projection horizon.

OTHER ECONOMIC COMPONENTS OF THE ACTUARIAL PROJECTION

The projections of GDP complete the actuarial analysis. This section uses the three GDP projections of the SSA actuaries from the 1992 trustees report corresponding to the three demographic projections just described. In addition to a demographic forecast, each GDP projection implicitly employs numerous other forecasts, including those of the labor force participation rate, the unemployment rate, the inflation rate, the rate of productivity growth, and the relationship between productivity growth and earnings growth.

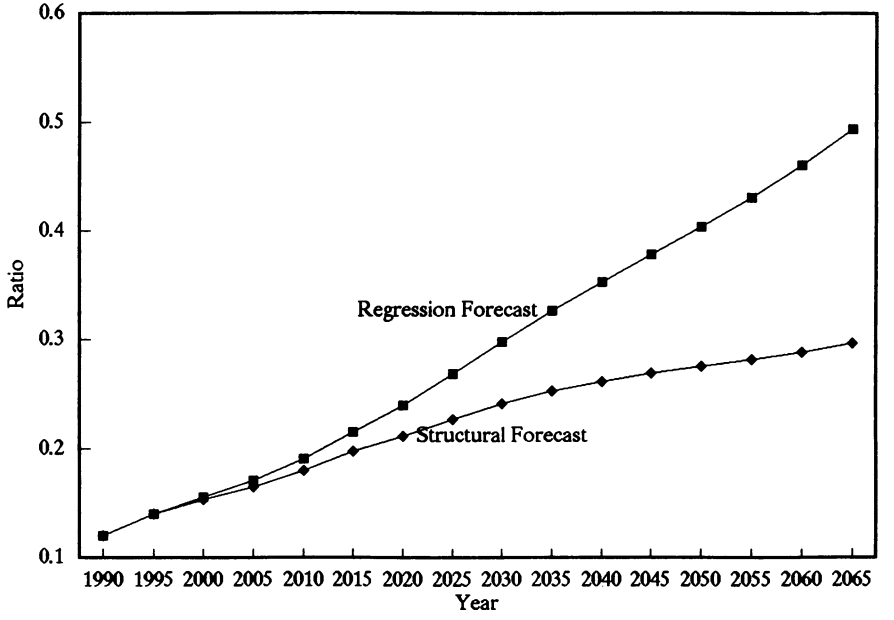
The various forecasts used in the intermediate GDP projection of the SSA are presented now. For men, the projected age-adjusted labor force participation rate for the year 2065 is 2.3 percent lower than the 1990 level of 76.6 percent; for women, the participation rate is 1.0 percent higher in 2065 than the 1990 level of 57.6 percent. The ultimate unemployment rate is projected to be 6.0 percent, reached by the year 2000 with a temporary low in 1994 resulting from a bounce-back from the 1990–1991 recession. The inflation rate is 4.9 percent in 1990; thereafter it is projected to be 4.0 percent. The ultimate annual increase in productivity is forecast to be 1.5 percent. The corresponding assumed rate of earnings growth, 1.3 percent, is reconciled by an assumed annual decrease of 0.2 percent in average hours worked per year.

PROJECTED RATIOS OF HEALTH EXPENDITURES TO GDP

The projected ratios of health care expenditures to GDP under regression and structural inflation forecasts are shown in Figure 2. Under the regression forecast, the ratio of health spending to GDP is projected to increase from the current level of 13 percent to almost 50 percent in 2065. The climb is fast throughout the projection horizon, accelerating somewhat in 2010 when the baby boom generation reaches late middle age.

Under the structural forecast, the ratio of expenditures to GDP is projected to increase from 13 percent to about 30 percent in 2065. The projection for the year 2000 is 15.3 percent. The climb through 2010 is due

Figure 2: Projected Ratio of Health Care Expenditures to Gross Domestic Product–Actuarial Approach under Intermediate Demographic and Economic Projections



mainly to the continued fast pace of health care price inflation, while the climb after 2010 is also due to the aging of the population. After 2045 and the passing of the baby boom generation, the pace of increase slows somewhat.[4] An asymptote is never reached under either price forecast, however, because the rate of change in real health care expenditures exceeds the ultimate rate of growth in real GDP: 1.3 percent.

The regression and structural forecasts of health care expenditures can be compared. Through the year 2000, the two forecasts are nearly identical. Thereafter a small divergence begins, with the regression forecast producing somewhat higher expenditures. After 2015, the divergence widens further, as the rate of increase in age-adjusted real health expenditures under the structural forecast falls to 1.6 percent, while the rate of increase is 2.5 percent under the regression forecast. There is a more rapid climb in the relative price of health care services under the regression forecast.

More detail on the projection under the structural price forecast and the intermediate demographic and economic scenario is shown in the top panel of Table 2. As mentioned earlier, the HCFA actuaries produced an age and source-of-payment profile for health care expenditures. Hence, it

is possible to project health expenditures by source of payment, such as by Medicare and Medicaid. The projected ratio to GDP of public expenditures by all levels of government on health care increases from 5 percent in 1991 to about 14 percent in 2065. The ratio of Medicare expenditures to GDP increases from over 2 percent to almost 7 percent, while the ratio for Medicaid increases from 1 percent to 3 percent.

Selected projections of health care expenditures under the two other demographic and economic scenarios, using structural forecasts of health price inflation appropriate to the scenarios, are shown in the remainder of Table 2. Under the optimistic projection, shown in the middle panel, the share of GDP devoted to health expenditures increases from 12 percent in 1990 to 27 percent in 2065. This growth comes about from the continued rapid rate of health price inflation, as well as from the aging of the population. Medicare expenditures increase from 2 to 5½ percent of GDP. Under the pessimistic projection, shown in the bottom panel, the share of GDP devoted to health care increases to almost 33 percent, while Medicare expenditures increase to almost 8½ percent. Clearly, the more pronounced aging present in the pessimistic projection causes the higher health expenditures.

SUSTAINABILITY OF PROJECTED EXPENDITURES

A judgment on the sustainability of current trends in the health care sector, using the ratio of expenditures to GDP as a measuring rod, depends on

Table 2: Actuarial Projections of Health Expenditures as a Share of Gross Domestic Product, Structural Inflation Forecast, Various Demographic and Economic Scenarios

	1990	*2000*	*2015*	*2040*	*2065*
Intermediate					
Total sector	12.0	15.3	19.8	26.2	29.7
All public	4.8	6.1	7.9	11.8	13.6
Medicare	2.0	2.5	3.5	5.7	6.7
Medicaid	1.1	1.5	1.8	2.6	2.9
Optimistic					
Total sector	12.0	15.3	20.1	25.4	27.4
All public	4.8	6.0	7.9	11.0	11.7
Medicare	2.0	2.5	3.4	5.1	5.4
Medicaid	1.1	1.5	1.8	2.5	2.6
Pessimistic					
Total sector	12.0	15.4	19.8	27.1	32.8
All public	4.8	6.2	8.1	12.7	16.1
Medicare	2.0	2.6	3.6	6.4	8.4
Medicaid	1.1	1.5	1.8	2.7	3.4

many factors. Are the attained levels sensible? Is the rate of change reasonable? Are there known areas of vulnerability? Focusing on the intermediate projections and on the regression forecast–and hence implicitly assuming that current price trends will continue–it does not seem sensible to expect that our society will eventually allow close to half of the national income to be devoted to health care.

Focusing on the intermediate projections and on the structural inflation forecast–that is, assuming that current trends will moderate somewhat–it is also unlikely that society will tolerate 30 percent of the national income to be expended on health care. Moreover, the actuarial model under the structural forecast foresees that the rapid rate of change in the ratio of expenditures to GDP will continue: from 1970 to 1991, the ratio went from 7½ percent to 13 percent; from 1991 to 2010, the ratio is projected to increase from 13 percent to 18 percent. If the current rate of change has caused discomfort, surely the projected rate will continue to do so. Finally, it is probably not feasible economically or politically to increase tax rates–almost 9 percentage points–or to raise budget deficits to continue to pay for the health care of those covered currently by government programs.

Variation of the demographic and economic assumptions underlying the projections changes the conclusions little. Under all three sets of assumptions, the ratio of total health care expenditures to GDP will be 20 percent in 2015. With expenditures reaching 3½ percent of GDP in 2015, and revenues continuing at the current rate of 2.2 percent of GDP, the Medicare program will be bankrupt significantly before 2015. Moreover, under the plausible pessimistic projection, health care expenditures will consume nearly a third of output by 2065, more than half, in turn, devoted to care of the elderly.

Based on actuarial analysis, therefore, current trends are not sustainable, absent major structural changes leading to economy in the health care system. Given the aging of the population and the hardening of expectations likely to result, such changes should be made quickly.

MACROECONOMIC ANALYSIS

The macroeconomic approach uses a simple general equilibrium model in which there are two sectors of production (health care and everything else) and two factors of production (labor and capital). Health care is produced in a Leontief fashion, that is, the input of labor and capital in fixed proportions is required. In contrast, output of the rest of the economy is a result of Cobb-Douglas production, that is, the substitution of labor and capital is technically feasible. Some dynamic change is allowed in both sectors, however, as "capital deepening" (explained further on) occurs in the health care sector,

and labor-augmenting technical change occurs in the rest of the economy. Expenditures on health care are exogenous to the model, determined by demographic factors, as in the actuarial approach. Saving, which determines capital accumulation, is a constant proportion of income. Labor supply is a function of demographic and sociological factors. Returns to labor and capital are equalized across the two production sectors.

Given parameter values reflecting best estimates of behavioral and technical conditions, initial levels of capital, and SSA demographic projections, the macroeconomic model is solved and simulated for long-range forecasts. In particular, the ratio of health care expenditures to national income is found, as well as the ratio of capital to labor, consumption per capita, and the impact of an increase in the saving rate.

Details of, and motivations for, the particular functional forms used and the assumptions made about parameter values are given in the next two subsections. As will be noted, certain variables were selected to make the model comparable with the Federal Reserve Board MPS (MIT–Pennsylvania–Social Science Research Council) quarterly econometric model of the U.S. economy (Brayton and Mauskopf 1985). The mathematical appendix for the macroeconomic simulation model is available from the author, upon request.

FUNCTIONAL FORMS OF PRODUCTION

It is assumed that "all other" output, that is, output excluding health care, is produced by a standard Cobb-Douglas production technology. Labor-augmenting technical progress is occurring at an annual rate of 1.2 percent, the current assumption of the MPS model. Labor's share of all other output is 70 percent, the value used by Maddison (1987) in his calculations explaining growth in advanced capitalist economies.

It is assumed that health care is produced by a Leontief production technology. This functional form can be justified on logical grounds. Structures and equipment, consistent with the state of medical knowledge and technology, are used by health care workers to assist in their provision of health care services. Nevertheless, health care remains a service given to individuals where the "human" element is considered essential and little substitution by machinery is possible. For example, a highly trained physician is required to diagnose an ailment and a nurse is essential in providing care and comfort to a hospital patient.

Cowing and Holtmann (1983) present econometric evidence inconsistent with the degree of substitutability between types of inputs necessary to assume a Cobb-Douglas specification for the production of health care services. In their study of 138 short-term, general care New York State

hospitals using 1975 data, Cowing and Holtmann showed a weak degree of substitution among different types of labor inputs, without even considering capital. Weisbrod (1991) documents the introduction of different types of new capital technologies in recent years and claims that, for the most part, they are not labor-saving devices. It will be further demonstrated below that a Leontief functional form is consistent with the recent behavior of health care prices and labor markets.

The amount of labor inputs used in the production of health care services is estimated from 1990 Bureau of Labor Statistics data. Hours worked in the health care sector are the product of the number of employees in the sector, the average hours worked per week by private hospital workers, and 52 weeks. The ratio of health care expenditures to this estimate of hours worked for 1990 is used as the parameter value for the fixed proportion of labor in the production function.

The capital used to produce health care is estimated using the Bureau of Economic Analysis accounts for fixed reproducible wealth in 1989. The aggregate net capital stock (current cost) in the health care sector is composed of federal, state, and local government hospital buildings; nonprofit hospital buildings; and structures and equipment at proprietary health care establishments (doctors' offices and for-profit hospitals). The only missing information is the stock of equipment at nonprofit and government hospitals. It is assumed that the ratio of equipment to structures in the nonprofit and government subsectors is identical to that in the proprietary subsector. This method produces an estimate of $497.2 billion in health care sector capital in 1989 and a ratio of output to capital of 1.2.[5] The ratio of output to capital (adjusted from book value to current cost) reported for hospitals in 1975 in Cowing and Holtmann–1.4–is broadly consistent with the aggregate estimate. It may also indicate that some "capital deepening," that is, the introduction of new, more sophisticated and expensive, equipment, has occurred from 1975 through 1989.

Although scope for capital deepening in the health care sector is included in the model, the estimated data on the aggregate capital stock are not reliable enough to allow inferences about the extent of capital deepening. The rapid introduction of computerized tomography (CT), magnetic resonance imaging (MRI), and other technology likely resulted in a lower ratio of output to capital in recent years, which Weisbrod (1991) ties to increasing relative prices for health care services. The macroeconomic model is simulated using different annual rates of capital deepening to demonstrate the consequences of such increases in the demand for capital in the health care sector on capital allocation among the sectors and on relative prices.

AGGREGATION

Aggregate output, that is income, is divided among three items. The consumption of health care services, of course, equals the output of the health care sector. It is assumed that the consumption of health care is a function of demographics and utilization rates alone and, because providers determine demand, is not much damped by increases in relative prices. Implicitly it is assumed that the trend toward fuller coverage of health care by government and private insurance programs will continue and, therefore, that individuals will not need to respond to possibly higher relative prices. In fact, the demand for health care in the macroeconomic model is determined in exactly the same way and using the same assumptions as the actuarial approach. The rest of output is divided between the gross domestic investment needed for the maintenance and growth of the private and public capital stock, and consumption of all other goods and services. Gross investment is assumed to be a constant percentage of income–19 percent–representing the rate of private and public gross domestic investment observed in the 1980s. Public gross investment includes federal, state, and local government expenditures on construction and durable goods. Consumption of all other goods and services is the residual of income.

The current year's aggregate capital stock is the sum of gross investment and the prior year's capital stock, less depreciation. Depreciation occurs at an annual rate of 6 percent, as implied in the MPS model. The initial level of the capital stock, in 1990, is $12.6 trillion. This level represents an extrapolation of 1989 figures for the sum of private residential and nonresidential and government fixed net capital, valued at current cost.

The current year's aggregate labor force, measured as hours worked, is a simple multiplicative function of population demographics, labor force participation and unemployment rates by age, and the average hours worked per week. The projected population follows the intermediate projection of the Social Security Administration. The projected rates of labor force participation by age are assumed to equal the average of rates experienced in the 1980s. The natural unemployment rate is assumed to equal 5 percent, with some adjustment for higher rates at young ages. Finally, the projected average hours worked per week is assumed to equal that observed in 1990 and to decline thereafter at a 0.2 percent annual rate.

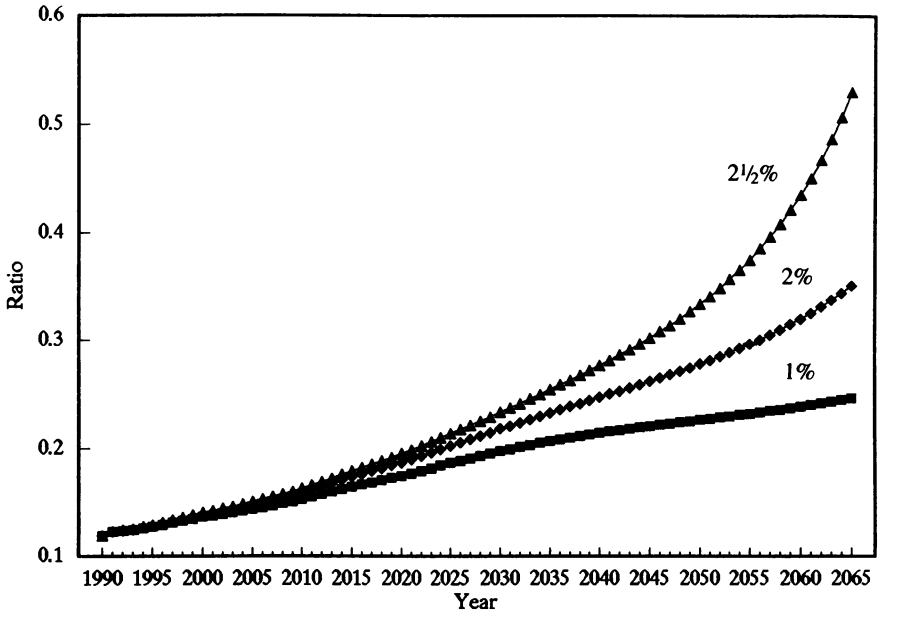
All labor and capital markets are perfectly competitive and continuously clear; in particular, hourly wages and benefits in the health care and all other sectors grow at equal rates. Adjustments are made for the recession beginning in late 1990 and lingering through 1992, by reducing projected "all other" output by 3 percent in 1991 and 1992, by 2 percent in 1993, and by 1 percent in 1994. Output in 1995 therefore grows faster than the trend rate.

As a final note on the macroeconomic model, welfare can be measured in two ways. First, consumption per capita, in 1990 dollars, measures welfare both absolutely and relative to economic conditions in prior years. Second, consumption less health care expenditures per capita, in 1990 dollars, highlights the resources remaining available for consumption of all other goods and services. The second welfare measure, in addition, may be thought to distinguish between goods and services that contribute directly and positively to an individual's sense of prosperity and comfort, such as fashionable clothing or gourmet dining, and those services that are necessary to rectify bad outcomes, but do not directly contribute to a sense of prosperity, such as health care services.

PROJECTIONS OF THE MACROECONOMIC SIMULATION MODEL

The projected ratios of health care expenditures to GDP under assumptions of 1, 2, and 2½ percent annual capital deepening in the health care sector are shown in Figure 3, corresponding to Figure 2 of the actuarial analysis.

Figure 3: Projected Ratio of Health Care Expenditures to Gross Domestic Product–Macroeconomic Simulation Model with Varying Rates of Capital Deepening in the Health Sector



Under the assumption of 1 percent capital deepening, the ratio of health expenditures to GDP is projected to increase from 12 percent in 1990 to almost 25 percent in 2065. The model with these assumptions predicts a ratio of 12.4 percent in 1991, below the actual ratio observed in 1991–12.8 percent. By 2000, the ratio is projected to reach 13.7 percent, and by 2010, 15.3 percent. The pace of increase in the ratio is fastest through the years of retirement and passing of the baby boom generation and levels off somewhat after 2040. The ratio here is slightly lower than the ratios produced using actuarial analysis, owing to the lower rate of health care price inflation implicit in the macroeconomic model when capital deepening is 1 percent or less.

Under the assumption of 2 percent capital deepening, the ratio of health expenditures to GDP is projected to increase to 35 percent over a 75-year horizon. The pace of increase is more uniform than when capital deepening is slower. By 1991, the ratio reaches 12.5 percent, by 1996, 13.1 percent, by 2000, 13.9 percent, and by 2010, 15.9 percent. Under the assumption of 2½ percent capital deepening, the ratio is projected to increase to 53 percent. As capital flows from the more productive sectors of the economy to the health care sector, growth in GDP slows considerably and the burden of health care expenditures rises significantly.

The importance of capital flows among sectors to overall growth, welfare, and the burden of health care is highlighted in Table 3. As shown in the upper panel, if capital deepening in the health care sector occurs at a slow rate of 1 percent, consumption per capita grows at a respectable 0.54 percent annual rate, that is, from $17,200 in 1990 to $25,800 in 2065 (all stated in 1990 dollars), and all other consumption per capita increases from $14,650 to $21,750. With gross investment occurring at a rate of 19 percent of GDP, the amount of aggregate capital accumulated, however, is not sufficient to maintain the ratio of capital to hours worked in the "all other" sector at the initial ratio of 60 to 1; it gradually declines to 34.5 to 1. As shown in the middle panel, if capital deepening occurs at a 2 percent rate, ultimate consumption per capita increases by about $3,000 less than under a slower rate of capital deepening, and the ratio of capital to labor in the all other sector declines further, to 21 to 1. If capital deepening in the health care sector occurs at a relatively fast rate of 2½ percent, consumption per capita increases at only a 0.12 percent annual rate, that is, to only $18,900, almost $7,000 less than under the slowest rate of capital deepening. Indeed, all other consumption per capita increases to only $14,900 in 2065, only $250 more than in 1990. Consumption falls in the quarter-century from 2040 through 2065! The ratio of capital to labor in all other sectors is cut to nearly a sixth of its original ratio, as capital is diverted to the increasingly capital-hungry, but inefficient, health

care sector and as faltering economic growth fails to produce enough capital overall.

The critical importance of capital accumulation to economic welfare, particularly when capital deepening in the health care sector is significant, can be shown in another way. Simulation exercises (not shown) repeat those shown in Table 3, but with an increase in the rate of gross investment, that is, savings, from 19 percent to 21 percent of GDP. In all cases of capital deepening, consumption per capita in 1990 declines by about $400 from the levels reported in Figure 3, reflecting the increase in investment. By 2015, however, the level of consumption is increased, as the boost in investment increases the capital stock, and hence total output. When capital deepening in the health care sector is occurring at a 2½ percent rate, consumption in the year 2065 in a scenario of 21 percent gross investment exceeds by $1,500 consumption in a scenario with 19 percent gross investment. Furthermore, with higher investment and output, the ratio of health care expenditures to GDP in 2065 declines from 53 percent to 45 percent. If capital deepening in

Table 3: Macroeconomic Simulation Model Welfare Measures (Consumption per Capita in 1990 Dollars)

	1990	*2015*	*2040*	*2065*
1 Percent capital deepening				
Consumption per capita	$17,188	$20,982	$23,152	$25,773
Consumption per capita (excluding health care)	14,654	17,630	19,260	21,746
Memo. Ratio of capital to labor: all other sectors	60.6	57.2	47.1	34.5
2 Percent capital deepening				
Consumption per capita	$17,186	$20,720	$22,137	$22,661
Consumption per capita (excluding health care)	14,651	17,368	18,245	18,635
Memo. Ratio of capital to labor: all other sectors	60.5	54.5	39.6	21.0
2½ Percent capital deepening				
Consumption per capita	$17,185	$20,564	$21,371	$18,914
Consumption per capita (excluding health care)	14,650	17,212	17,479	14,888
Memo. Ratio of capital to labor: all other sectors	60.5	52.9	34.5	10.3

Note: Gross investment is assumed to be 19 percent of gross domestic product.

the health care sector is occurring at a 2 percent rate, increased investment boosts consumption by $725 by the year 2065. In all cases, the ratio of capital to labor either rises or falls more slowly when gross investment is higher.

LABOR MARKET IMPLICATIONS

This macroeconomic model, with a Leontief technology for health care services, has particularly accurate implications for the share of the labor force working in the health care sector. One might think that along with a quarter (or third or half) of GDP going toward health care at the end of the projection horizon, a quarter (or third or half) of the labor force would also be working in the health care sector. This is not the case. Regardless of the rate of capital deepening in the health care sector, the share of the aggregate labor force (actually hours worked) in the health care sector increases from 8 percent in 1990 to 15½ percent in 2065.

The reason for this result is as follows. Because the analysis is done in 1990 dollars, the price of "all other" output declines, while the price of health care remains constant; that is, the relative price of health care rises. According to the model, total health care spending in 1990 dollars only about doubles over the projection horizon. Because the fixed coefficient in the health care services production function is constant, and the total labor force does not increase much over the projection horizon, the share of the total labor force in the health care sector also only doubles.

The share of the total labor force in the health care sector has only increased about 1½ percentage points over the last 15 years, in contrast to an increase in spending of nearly 5 percentage points in the share of GDP and rapidly rising relative prices. The macroeconomic model is therefore entirely consistent with this experience, particularly if one of the more rapid rates of capital deepening is used in the simulations.

Some concern has been expressed that the particular specification used in the macroeconomic model here–especially the inability of the health care sector to substitute labor and capital–drives all of the results. It is the case that the specification used does fit uniquely the behavior of the labor market and has strongly adverse long-term implications for economic welfare and the allocation of capital. Nevertheless, even if production in all sectors shows substitution approaching the Cobb-Douglas model, as long as the health care sector lags in productivity improvements and the demand for health care services is inelastic and increasing, the share of national output devoted to health care will continue to rise steadily. Moreover, the long-term implications for economic welfare are still somewhat poor because the health care sector starts out as a labor-intensive sector. Therefore, even in a

completely Cobb-Douglas model, the scope for substitution is limited; while the share of the labor force in the health care sector will increase faster than the share of health expenditures in output, as capital is diverted away from health care and toward the more efficient "all other" sector, production increases possible from the substitution of labor and capital are small.

SUSTAINABILITY OF PROJECTED EXPENDITURES

The judgment on the sustainability of current trends in the health care sector, based on economic analysis, is somewhat harsher than the judgment based on actuarial analysis. If capital deepening in the health care sector is occurring at a 1 percent rate, the resulting gradual climb in, and ultimate outcome of, the ratio of health care expenditures to GDP is of questionable sustainability. In the other cases, the trends are certainly not sustainable, absent significant structural changes in the health care sector and the economy. The reasons for this conclusion are the same as those underlying the results of the actuarial analysis, namely, an unrealistically high level of resources ultimately being devoted to health care, too rapid a growth rate in health spending, the bankruptcy of Medicare, and the political exposure of vulnerable groups in the population. Moreover, the improvement in economic welfare is crimped, and, in one simulation case, the rate of growth in per capita consumption eventually becomes negative, indicating the possibility of general and severe social dislocations. Macroeconomic analysis indicates that an increase in the overall rate of gross investment would be beneficial in these environments.

CONCLUSION

This article projects health care expenditures as a share of GDP, using two methodological approaches, under various sensitivity checks. The results indicate unanimously a continued increase in the ratio of health care expenditures to GDP. Even the most conservative projections, which assume either robust economic growth, improved demographic trends, or some moderation in health care price inflation, foresee the health care sector consuming more than a quarter of national output by 2065. If, on the other hand, current relative price trends continue, economic growth remains anemic, demographic trends continue or worsen, or the health care sector becomes a major user of capital, both actuarial and macroeconomic approaches predict that health care expenditures will comprise between a third to a half of national output. Given such scenarios, the institutional and economic underpinnings of even the most efficient and beneficial sectors

would need rethinking. In the case of the health care sector, where discontent is already high and even greater problems with major public programs loom in the near future, serious and immediate structural reform is critical.

ACKNOWLEDGMENT

The article has benefited from the helpful comments and suggestions of the editor, two anonymous reviewers, and of Peter Tinsley, Jeff Lemieux, David Stockton, Oliver Garnier, Darrel Cohen, and participants of seminars at the 1992 NBER Summer Institute, 1991 Atlantic Economic Association meetings, Congressional Budget Office, WEFA Group, and Health Care Financing Administration. Katie B. Fagan provided excellent research assistance.

NOTES

1. The idea of differential productivity growth in sectors of the economy was first proposed, in an entirely different context, by Baumol (1967).
2. National health expenditures are derived by adding 14 percent to personal health expenditures. This addition reflects costs of government public health activities, administration of private health insurers, construction of hospitals, and government-sponsored medical research. These "overhead" costs are assumed proportional to the expenditures of the various age groups.
3. The robustness of the regression equation is demonstrated by the failure of the addition of a time trend variable to change the coefficients or their significance much and by the stability of the coefficients and their significance when first differences are taken.
4. A straight-line extrapolation of 1970-1991 experience produces a projected ratio of about 32.5 percent in 2065.
5. In contrast to the high ratio of output to capital observed in health care services, the ratio of output to capital in the entire service sector was 0.6, and for the economy taken as a whole, the ratio was around 0.4.

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